Computer Vision and Image Analysis Course

Lab 4: Setting up Raspberry Pi board & CubeSat edge detection using Pi camera module

Interdisciplinary Space Master (ISM)
Interdisciplinary Centre for Security, Reliability and Trust
Computer Vision, Imaging, and Machine Intelligence (CVI^2) group

Course Responsible: Prof. Djamila Aouada
TA: Dr. Leo Pauly, Dr. Nilotpal Sinha
djamila.aouada@uni.lu; leo.pauly@uni.lu; nilotpal.sinha@uni.lu

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Summary

The goal of this lab session is to familiarise with setting up the Raspberry Pi board and perform Cubesat edge detection on images captured using the Pi camera module. The following items shown in Figure 1 are provided for the lab session.

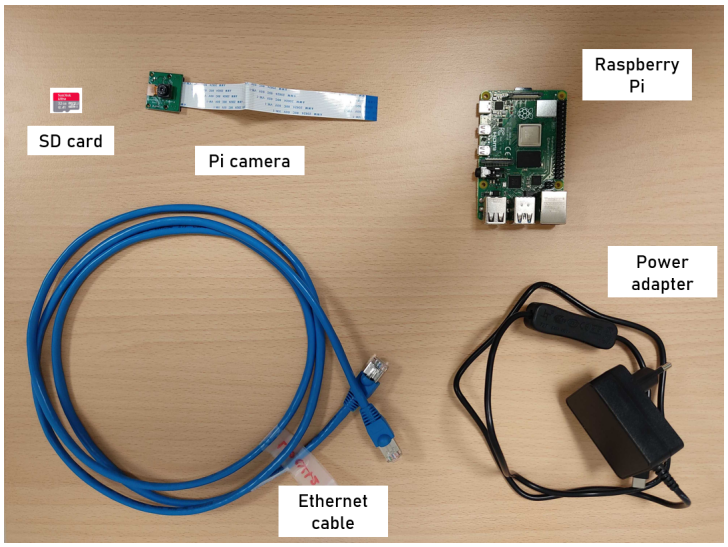

Figure 1: Raspberry Pi toolkit items

Preliminary set up

- Install MobaXterm (portable version can be used) on your host computer.

Download link:
https://mobaxterm.mobatek.net/download-home-edition.html

- Setup a virtual bridge connection between the WiFi and Ethernet adapters on the host machine to continue using internet after connecting to the Raspberry Pi. Make sure the WiFi is connected before setting up the bridge connection.

  Steps:

  - Click Start Menu > Control Panel > Network and Sharing Center or Network and Internet > Network and Sharing Center.
  - Click Change adapter settings.
  - Create a new bridge by first selecting the WiFi adapter and then the Ethernet adapter.
  - Finally right-click on the WiFi adapter (while both are selected) and select Bridge Connection.

  Make sure you are still connected to internet after bridging.

- Now insert the microSD card into Raspberry Pi board. Note that the microSD card is already pre-installed with Raspbian OS. However, Raspberry pi supports several other Operating Systems which can be installed into the microSD card using a Raspberry Pi Imager.

- Connect the power cable as show in Figure 2 and power ON the device.

Figure 2: Connecting power cable

- Now connect the laptop to Raspberry Pi board using the given Ethernet cable.

- Open MobaXterm on the host machine and connect to the board via SSH (password: raspberry) using the terminal.

Info:
% Checking connectivity
$ ping raspberrypi.local

% Connecting via ssh
$ ssh pi@raspberrypi.local

% Board IP address can also be used directly for an ssh connection
$ ssh pi@[board-IP-address]

% To obtain the board IP address assigned
$ ifconfig
% To get the file structure in MobaXterm along with ssh connection
$ ssh pi@[board-IP-address]

Task A: Cubesat edge detection using Pi camera

Info:
Use Python Imaging Library (PIL) and Numerical Python (Numpy).
Reference:
CVIA Image Filtering Notes

1. Connect Pi camera module to the board as show in Figure 3

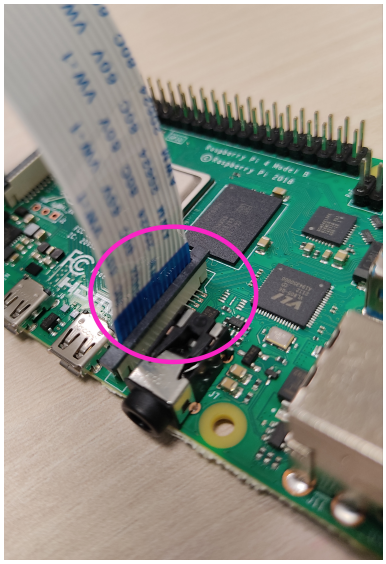

Figure 3: Connecting Pi camera module

2. Use /home/pi/Desktop/CVIA21_EdgeAI as the working directory.
3. Collect images of the Cubesat using Pi camera.

Useful function
$ raspistill

4. Read the image from the stored folder. Convert RGB image into grayscale (I_{gray}). **Store the results for the report.**

   Useful functions
   PIL.Image.open()
   PIL.ImageOps.grayscale()

5. Use Gaussian kernel to obtain the smoothened image I_{blur}. Use different radii and note the difference. **Store the results for the report**.

   Useful function:
   PIL.ImageFilter.GaussianBlur()

6. Compute image gradients along x-direction (G_x) using the horizontal Sobel filter. **Store the results for the report**.

   Useful function:
   PIL.ImageFilter.Kernel()

7. Compute image gradients along y-direction (G_y) using vertical Sobel filter. **Store the results for the report**.
8. Finally compute the gradient amplitude image (G_{amp}). **Store the results for the report**.

   Equation:

   $$||\nabla f|| = \sqrt{\left(\frac{\partial f}{\partial x}\right)^2 + \left(\frac{\partial f}{\partial y}\right)^2}$$

   Use the simplified version of the equation in the program.

   Hint:
   Convert images into numpy arrays for calculation.

Report all the obtained results (I , I_{gray}, I_{blur}, G_x, Gy, G_{amp}) and the code. Also, describe briefly how calculating gradients using Sobel filters can detect edges.

Additional info: Setting static IPs in the host machine and Raspberry Pi board

1. Setting static IP for the host machine.

   Steps (for Windows OS):

   - Click Start Menu > Control Panel > Network and Sharing Center or Network and Internet > Network and Sharing Center.
   - Click Change adapter settings.
   - Right-click on Ethernet adapter and select Properties.
   - Select Internet Protocol Version 4 (TCP/IPv4) and select Properties.
   - Select Use the following IP address. Enter the static IP address as 192.168.0.5, Subnet mask as 255.255.255.0 and DNS server as 192.168.0.1.
   - Click OK.

2. Setting static IP for the Raspberry pi board.

Steps:

```
$ sudo nano /etc/dhcpcd.conf

% Add the following to the file
interface eth0
static ip_address=STATIC_IP/24 % Use: 192.168.0.4/24
static routers=ROUTER_IP % Use: 192.168.0.1
static domain_name_servers=DNS_IP % Use: 192.168.0.1

% Now reboot the device
$ sudo reboot
```

END